A Framework for Scalable Trainable Image-based Query in Video

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Informedia-II
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Informedia Project

- Multi-modal query of video
  - Speech recognition
  - Text analysis
  - Object detection in video
- Visualization and Summarization
  - Multiple Video Documents
  - Topic collages

http://www.informedia.cs.cmu.edu

Lesson learned

- Image-based query is a powerful tool for finding relevant information
  - Informedia-I, Blobworld, QBIC, ect.

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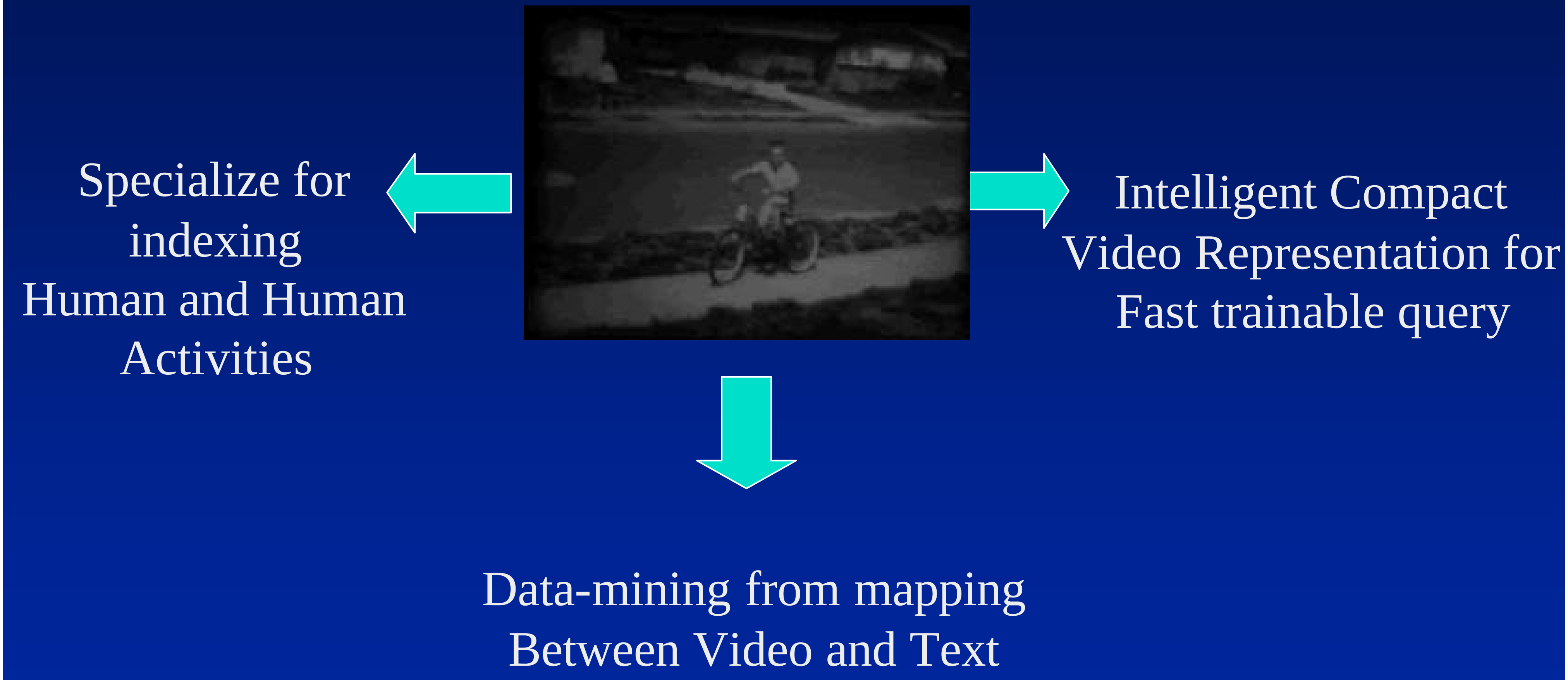
- Image-based query is a powerful tool for finding relevant information
  - Informedia-I, Blobworld, QBIC, ect.

- …but we are far from achieving
  - Human level object recognition
  - Rapid processing of massive video/image data
    - *The story is in the large of volume data*

Scaling Video Image Processing Engine



Specialize for indexing Human and Human Activities

Intelligent Compact Video Representation for Fast trainable query

Data-mining from mapping Between Video and Text

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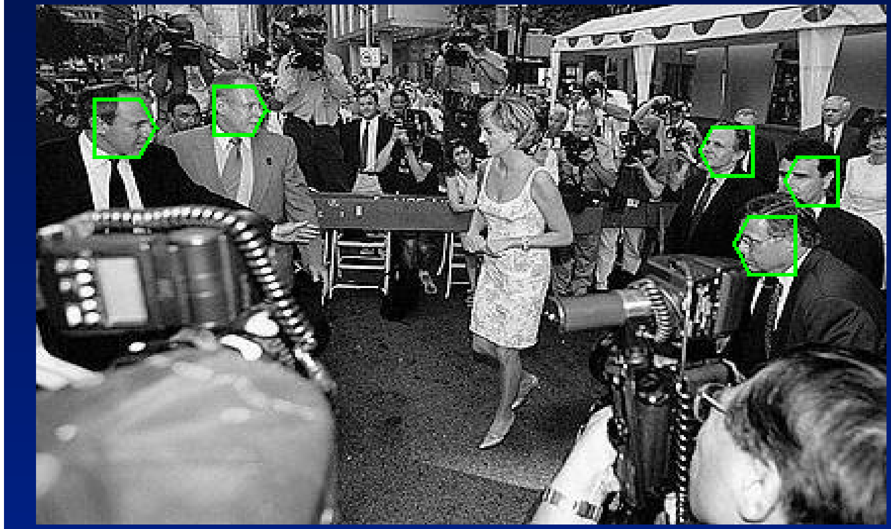
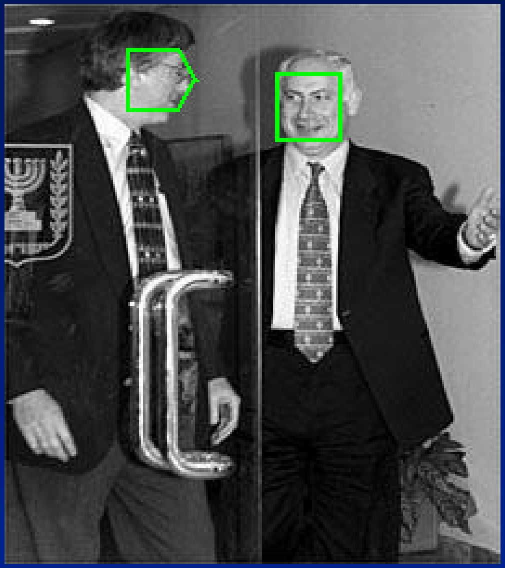
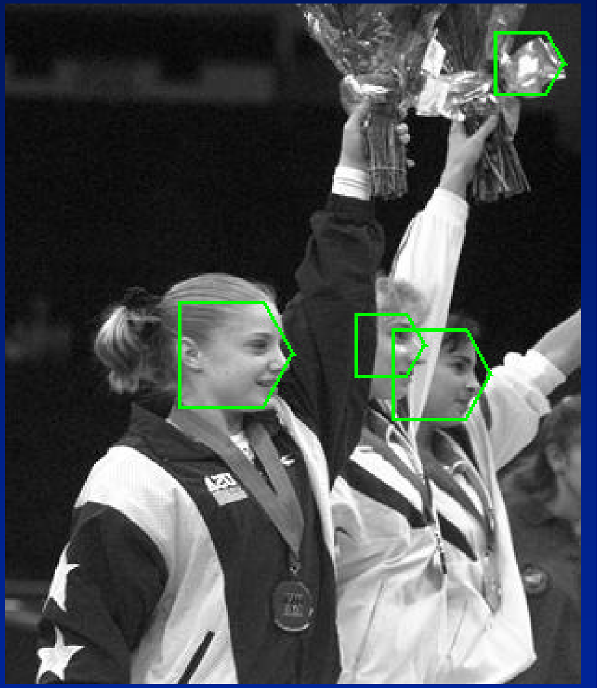
Human interests

Human Identity: Face

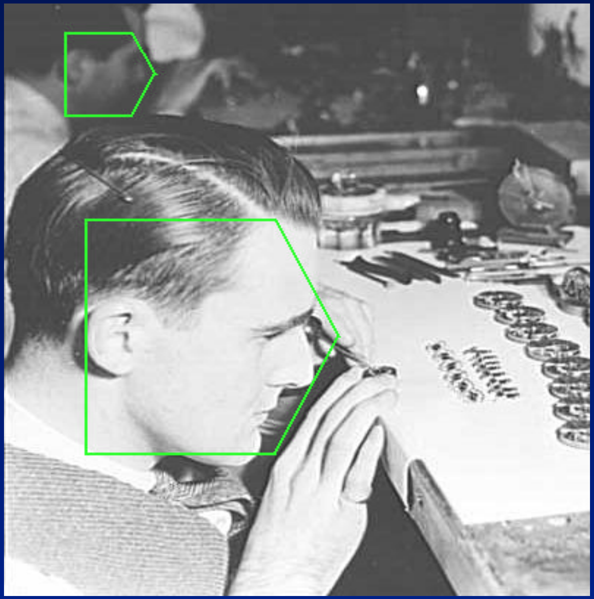
Human Activity Recognition: Body

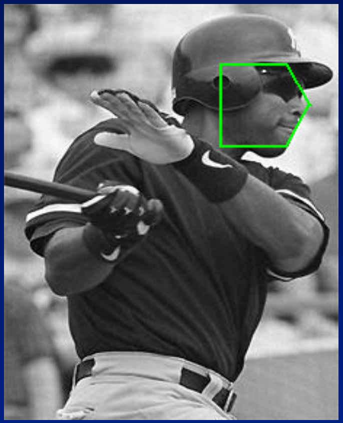


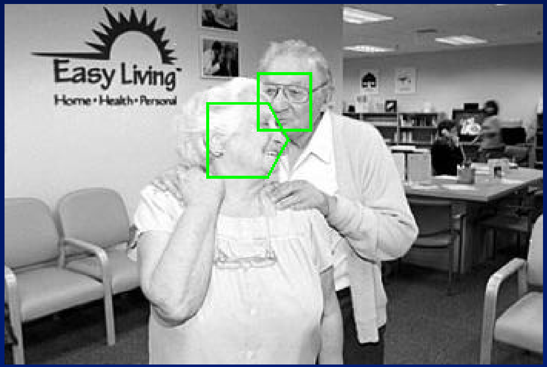




Face Detection - Henry Schneiderman (CMU)



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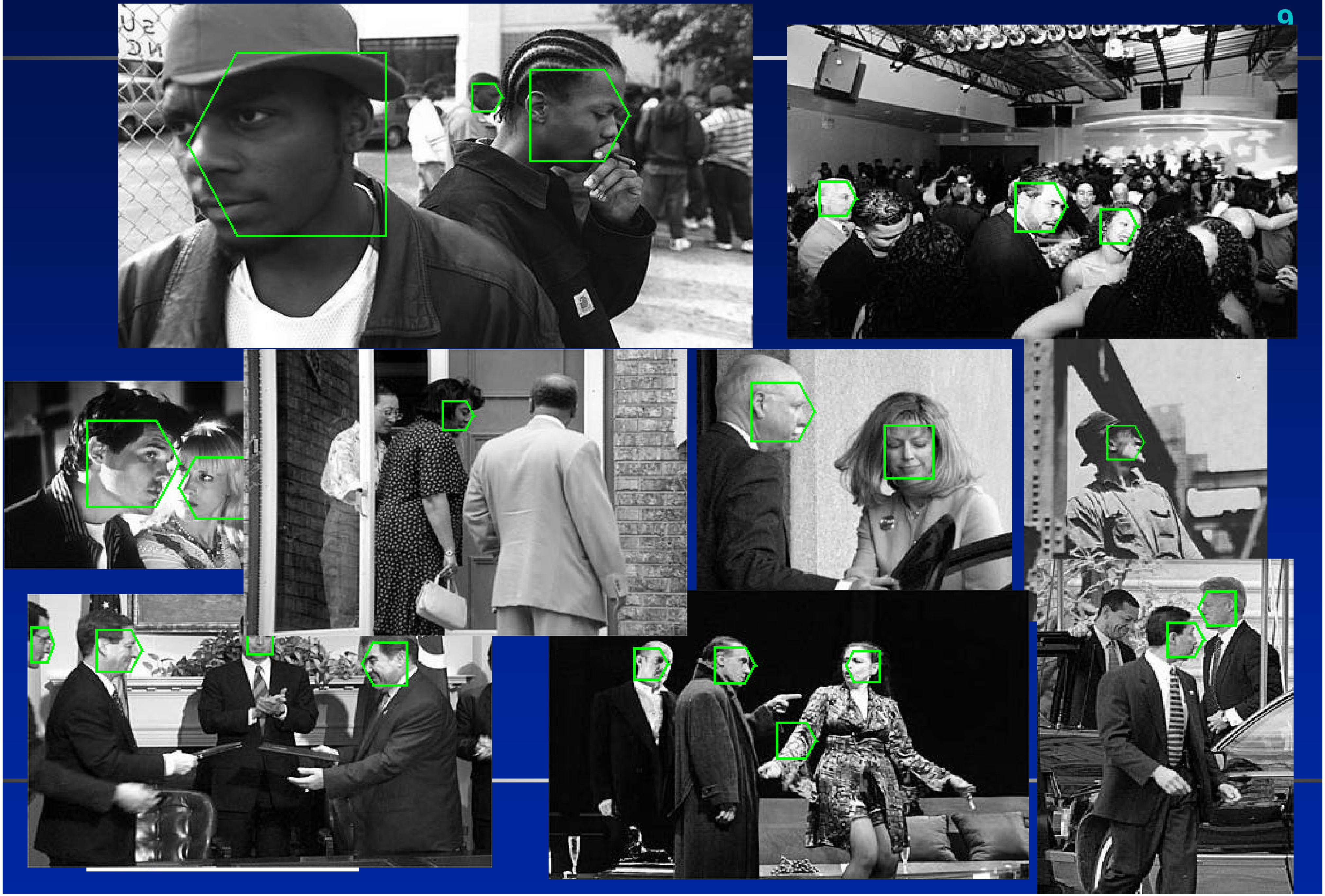


Body Detection/Activity Recognition in Video

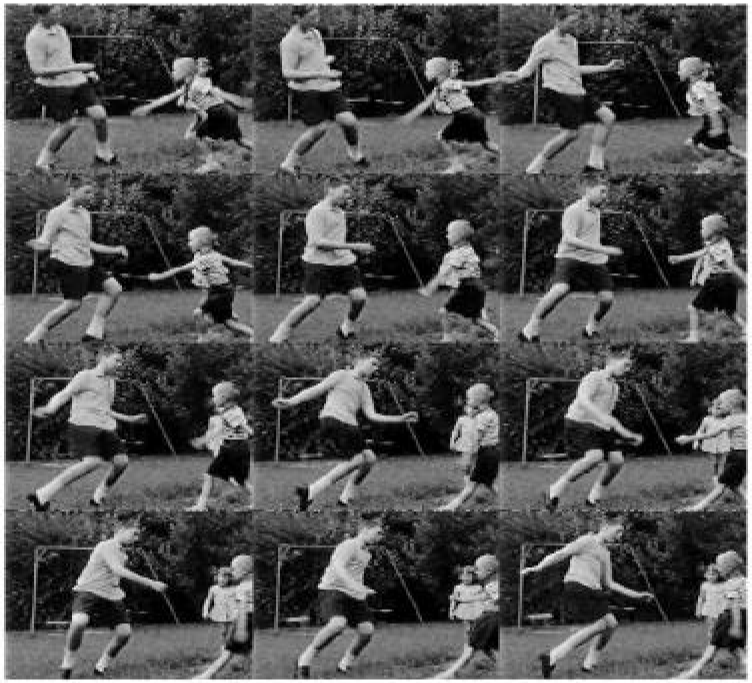
Detecting detecting human in video

Understanding human activity

Measuring/analyzing body movement

Recognizing human from body movement

The main difficulty:



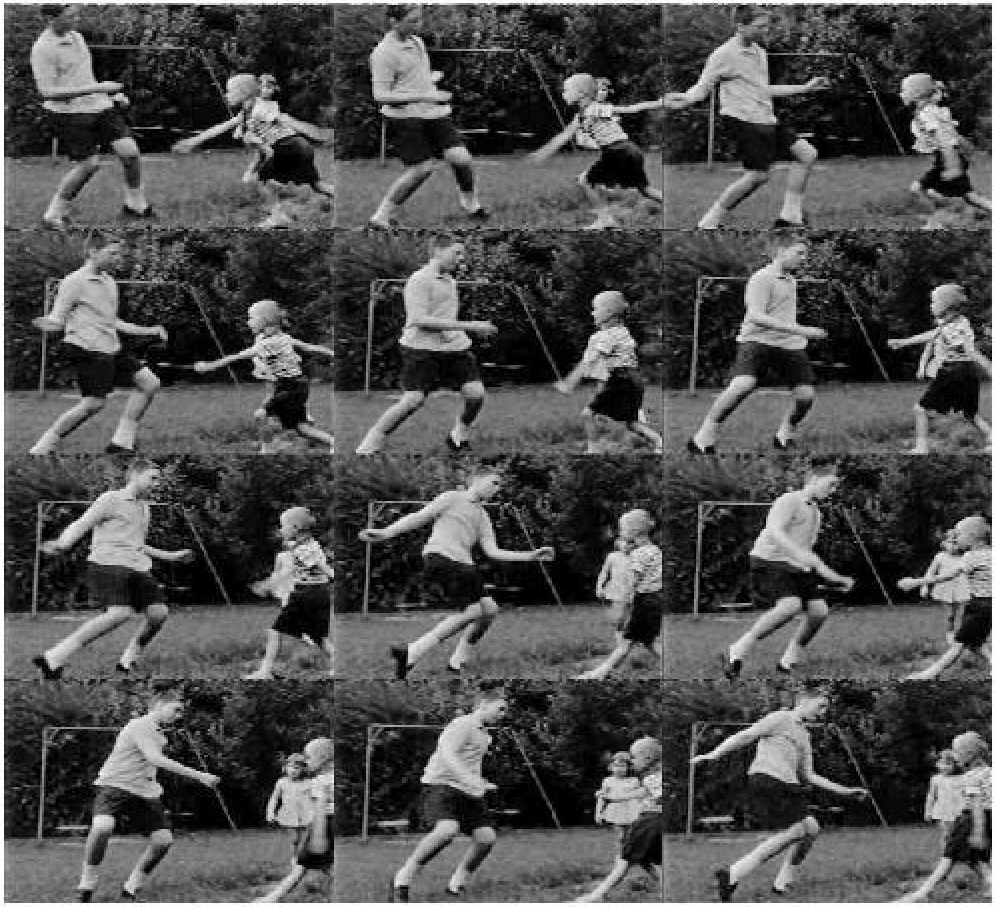
$$N = (npixel \times num\_orientation \times num\_scale)^{body\_parts}$$

$$= (10^6 \times 10^2 \times 5)^9 = 6 \times 10^{78}!$$

Existing Approach

- Controlled setting: background subtraction
- Hand initialization, user assisted tracking
- Grouping based body detection:
  - Forsyth, Finding Naked Body, ECCV’96
  - Felzenszwalb, Huttenlocher, ICCV’99

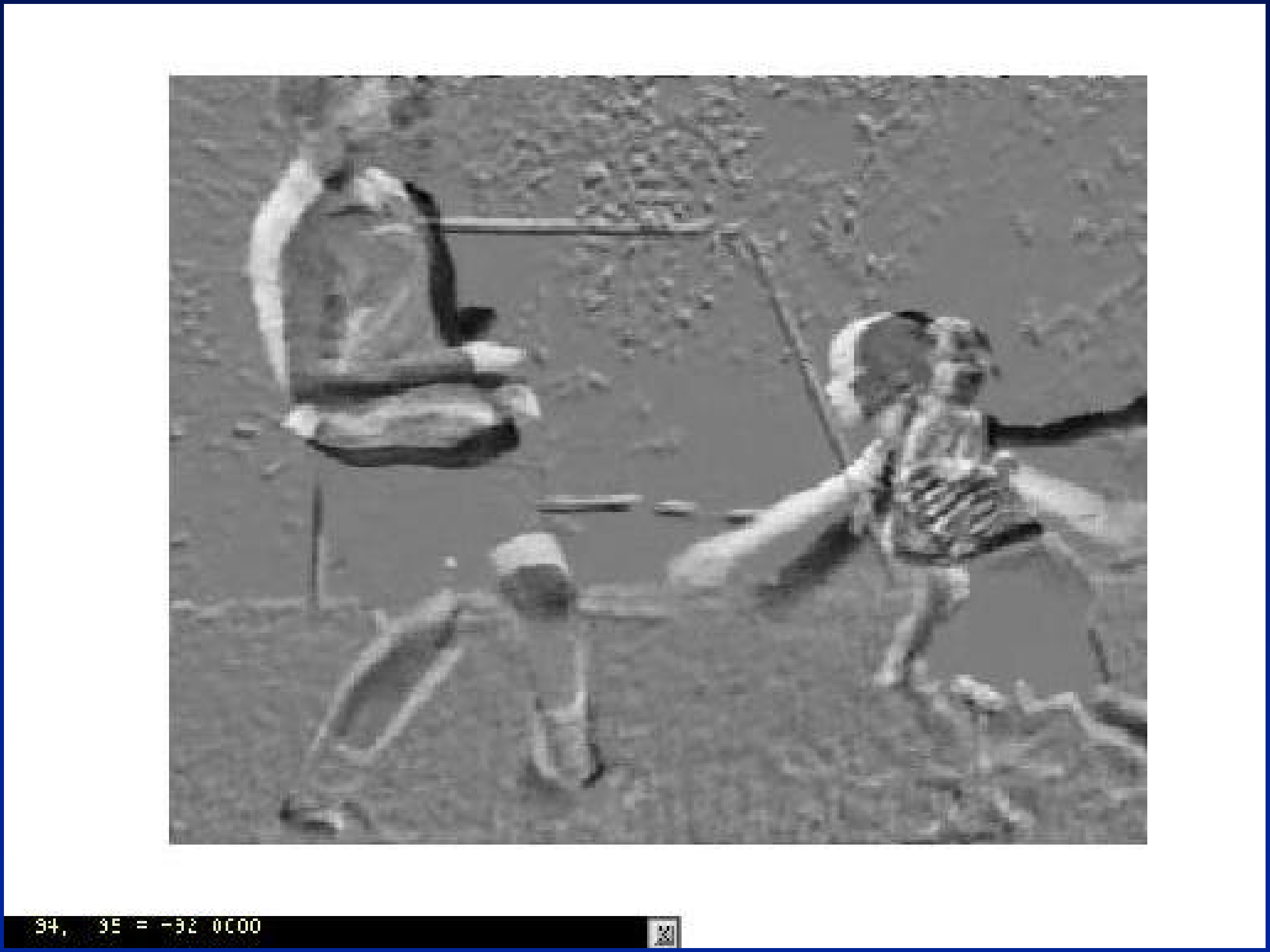
Body finding in a video:



Proposed approach

- Using motion information to find possible locations of joints,
- Using MRF inferencing technique for finding the globally optimal body configuration.

Joint location from motion field



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94,  95 = -32 0000
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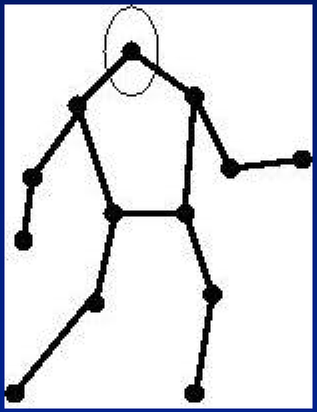
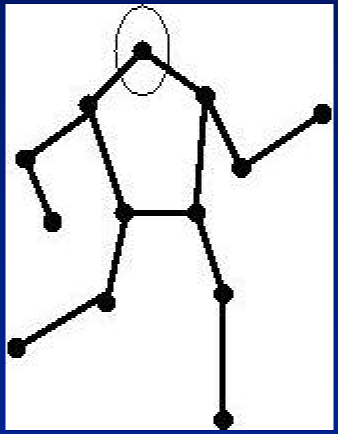
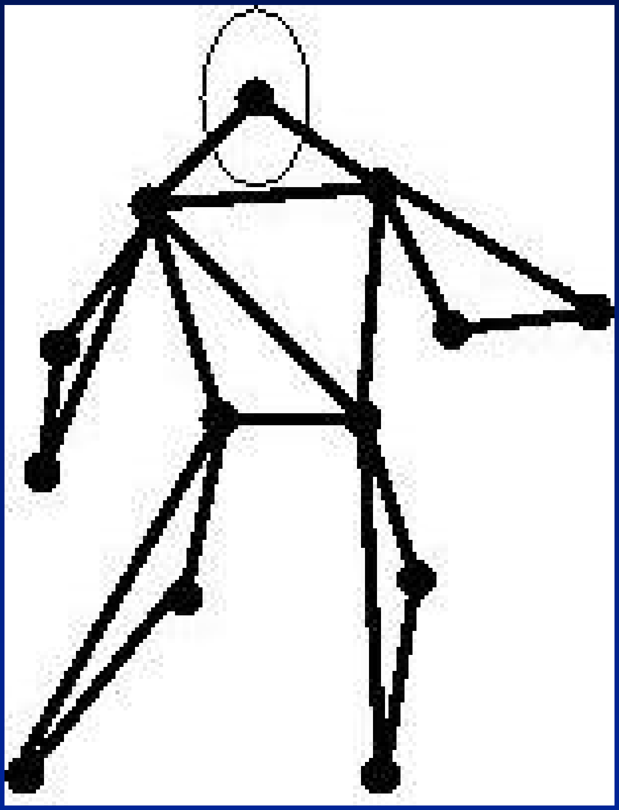




Body joint tree:

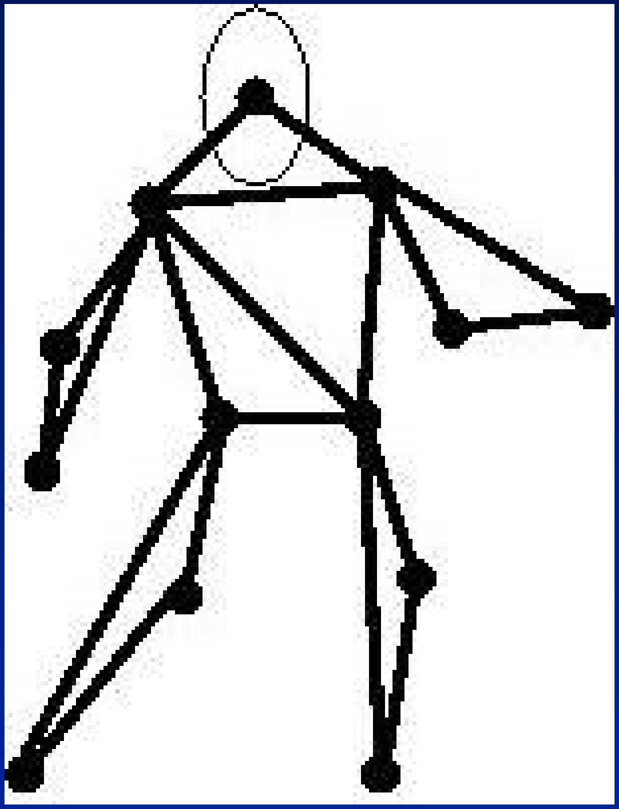


Let $L = (l_{1,} l_2, \ldots, l_n)$, be the assignment of each joints

$$E(L) = \sum_{(l_i, l_j, l_k)} E(l_{i,} l_{j,} l_k) + \sum_{l_i} E(I, l_i),$$

$$P(L) = \frac{1}{Z} e^{-E(L)}$$

Body joint tree:



$$E(L) = \sum_{(l_i, l_j, l_k)} E(l_i, l_j, l_k) + \sum_{l_i} E(I, l_i),$$

$E(I, l_i) =$ how likely l_i is a joint,

$E(l_i, l_j, l_k) =$ how likely is this configurat ion of three joints.

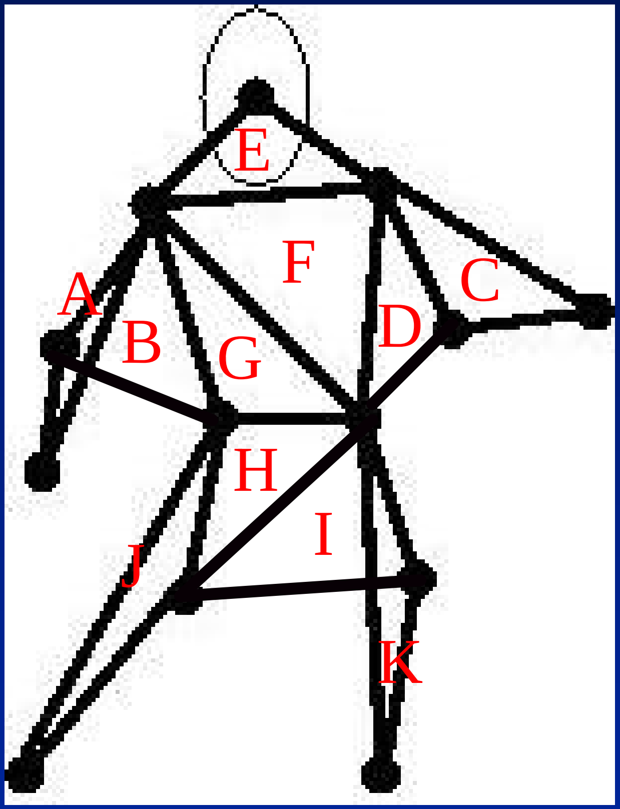
Depends on :

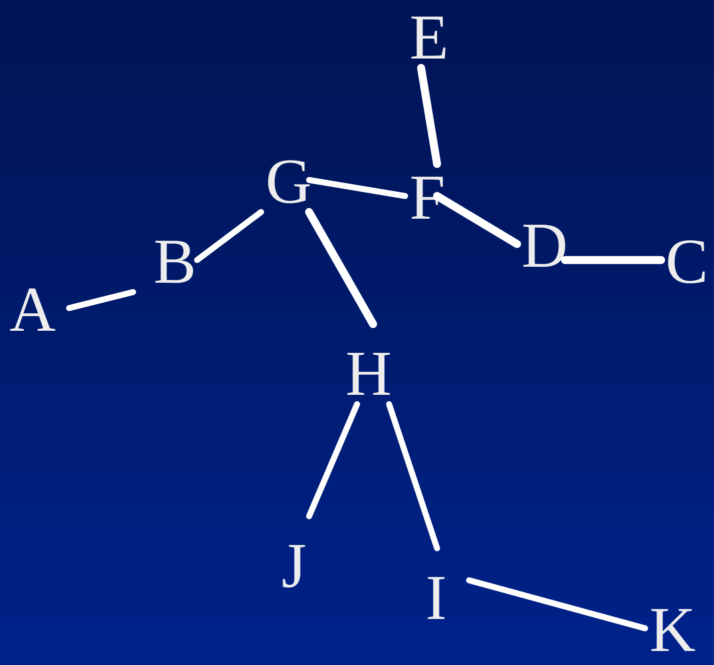
1) geometrica l relationsh ip,

2) relative motion,

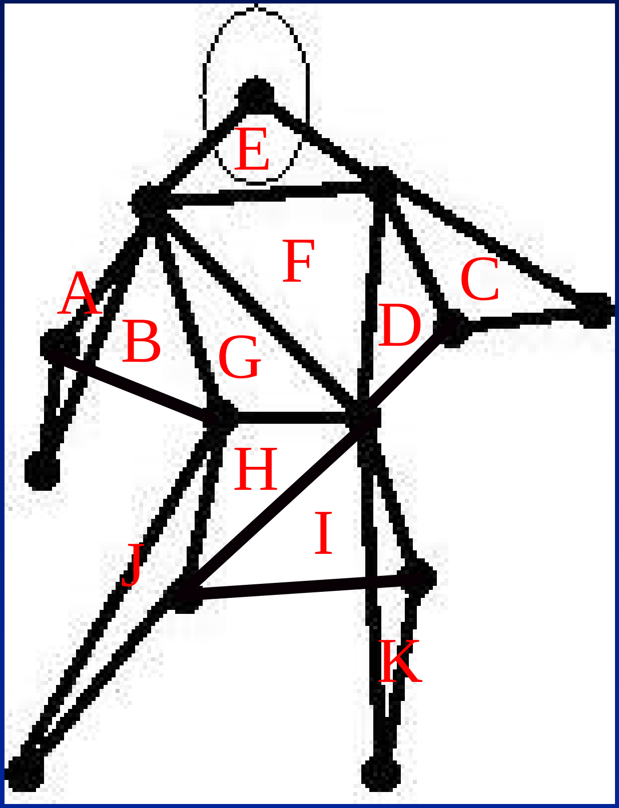
3) image informatio n.

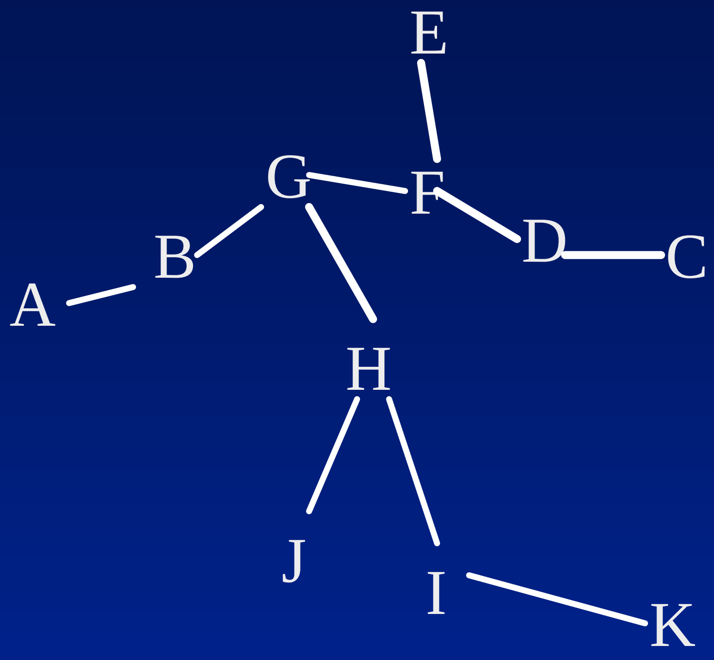
Clique tree





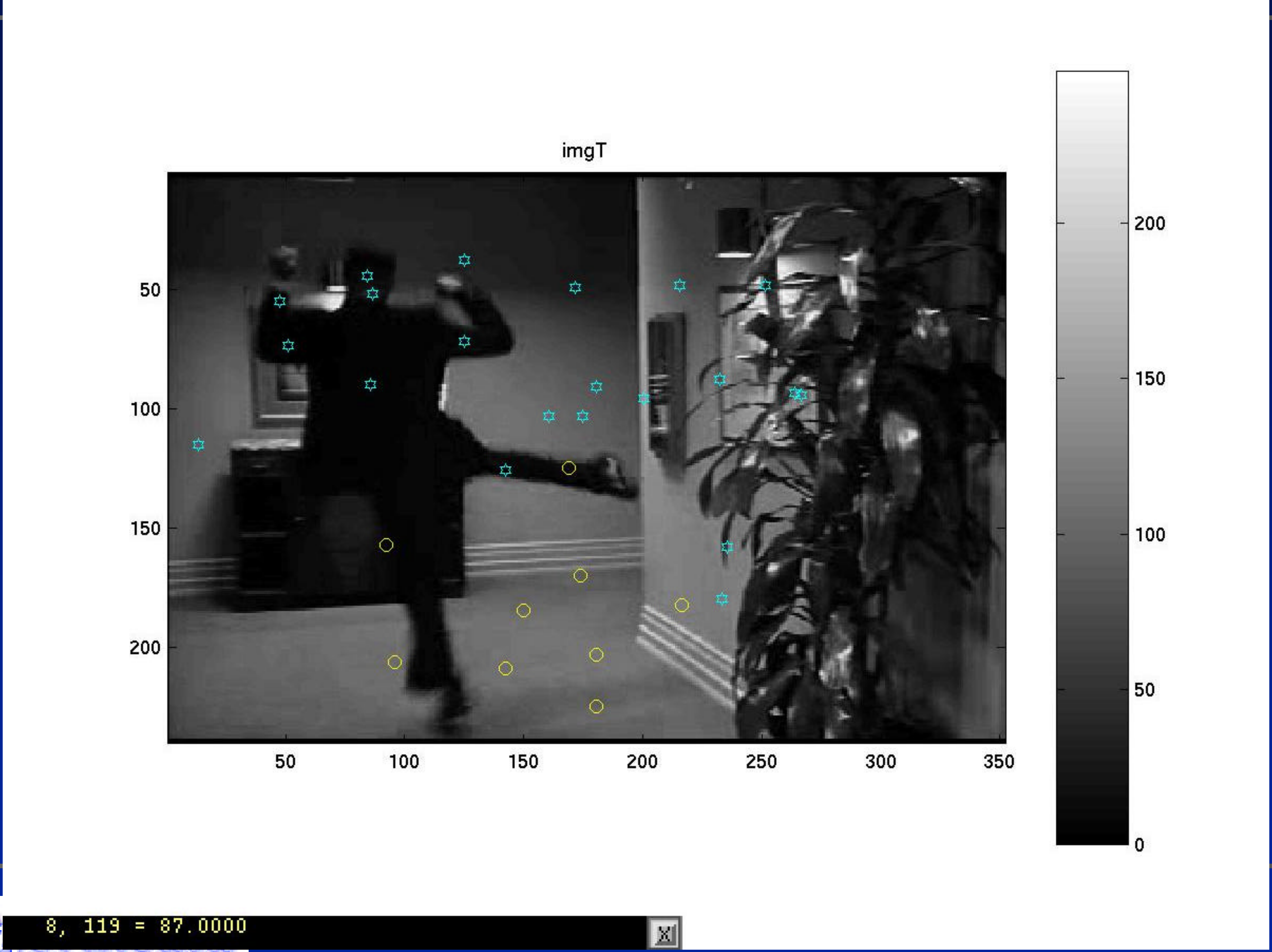
Clique tree





Run Dynamic programming on the clique tree above

Possible body-part locations:



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8, 119 = 87.0000
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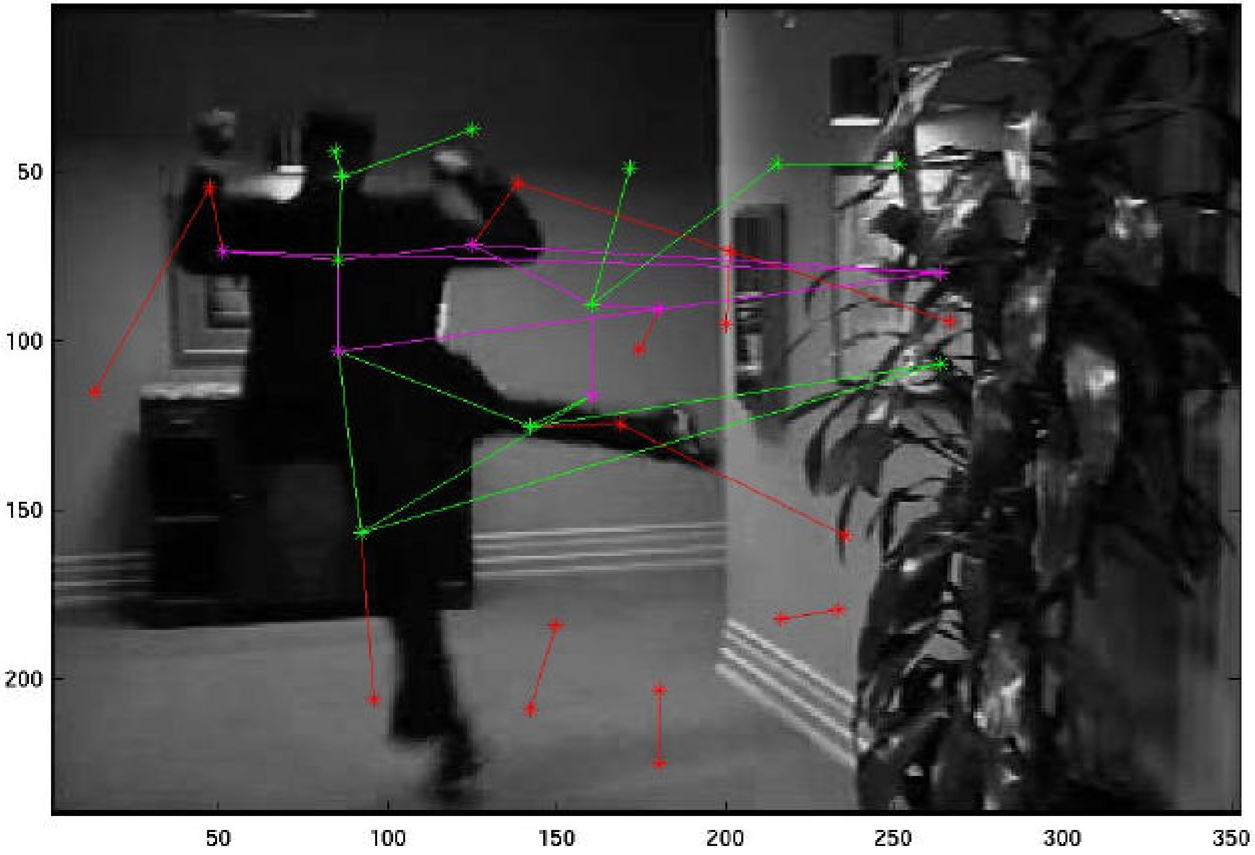
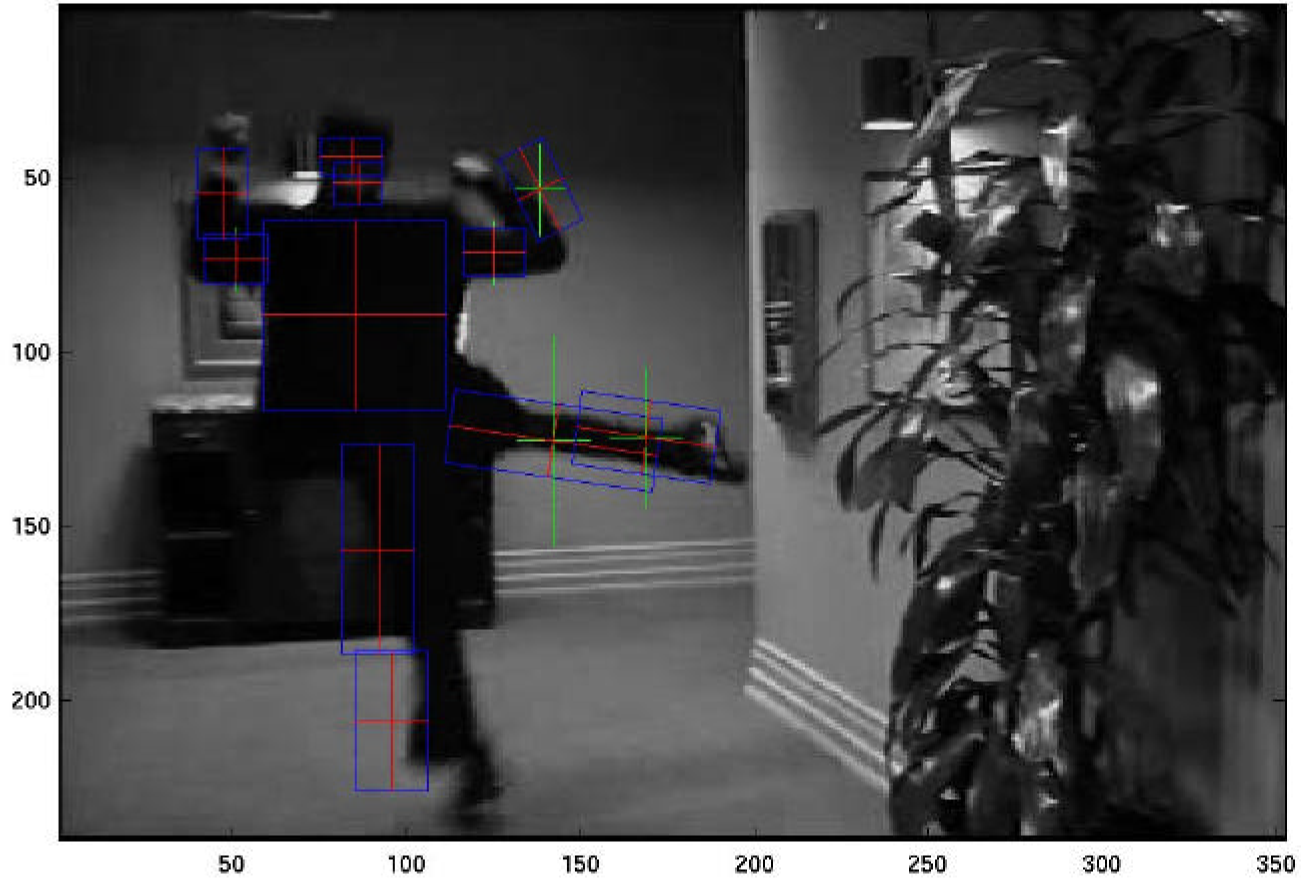
Some of the possible body configurations:



Optimal configuration:



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Efficient Representation of Video

Original Video Segment

(3.4Mb)

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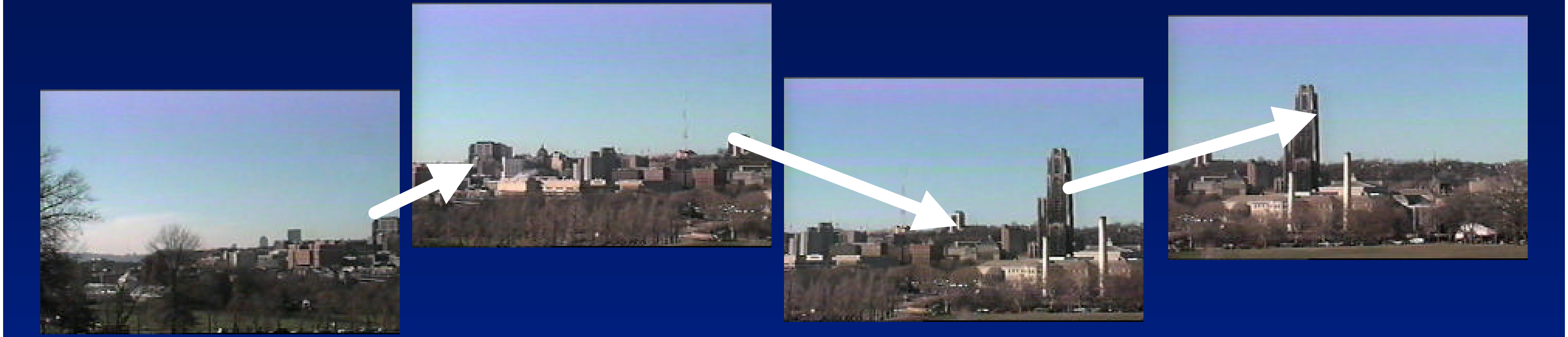
Image Registration:



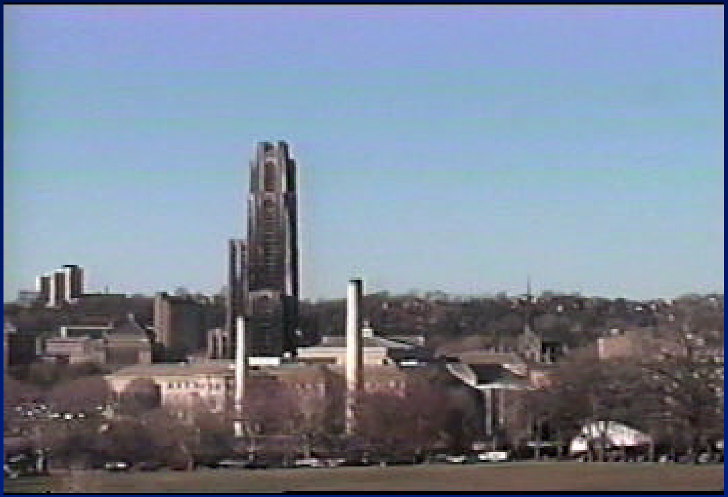
Compute the transformation between image I and J, using affine approximation:

$$J(Ax+D) = I(x)$$

Efficient Representation of Video

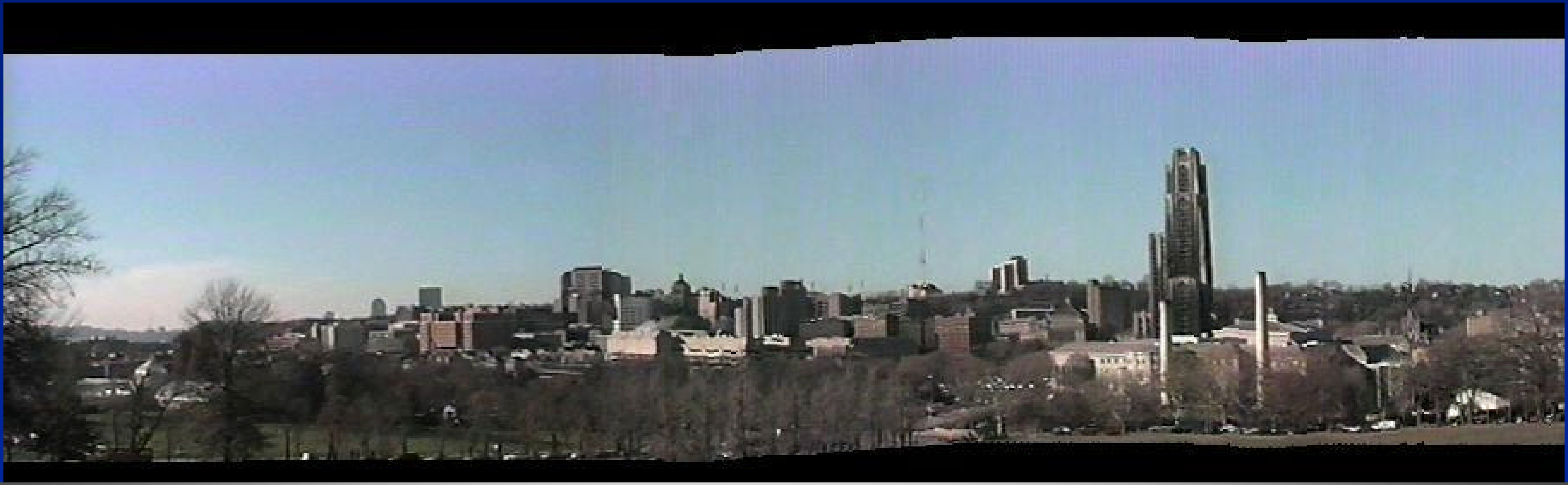
Original Video Segment

(3.4Mb)



Panorama Layer

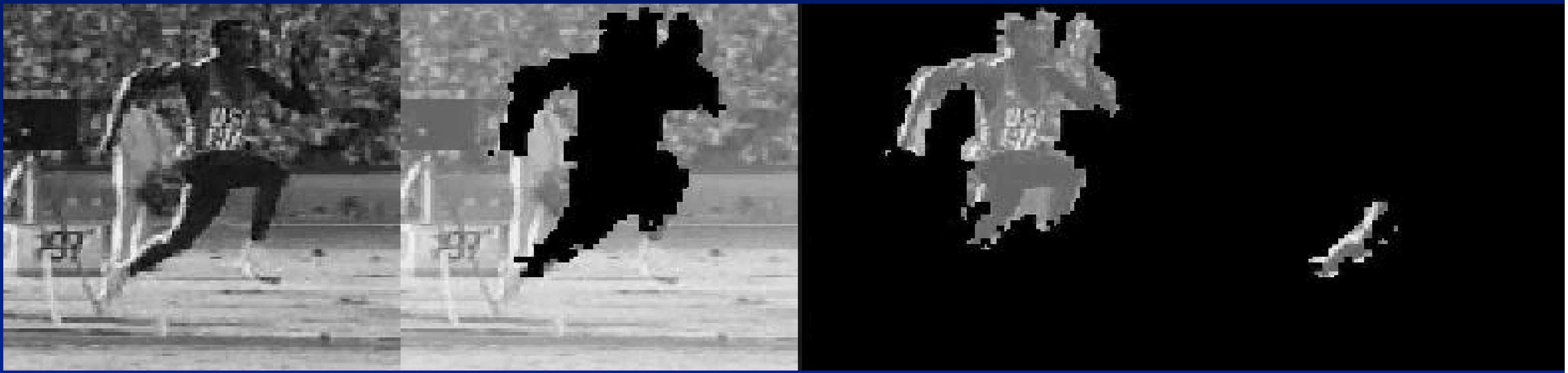
(35Kb)



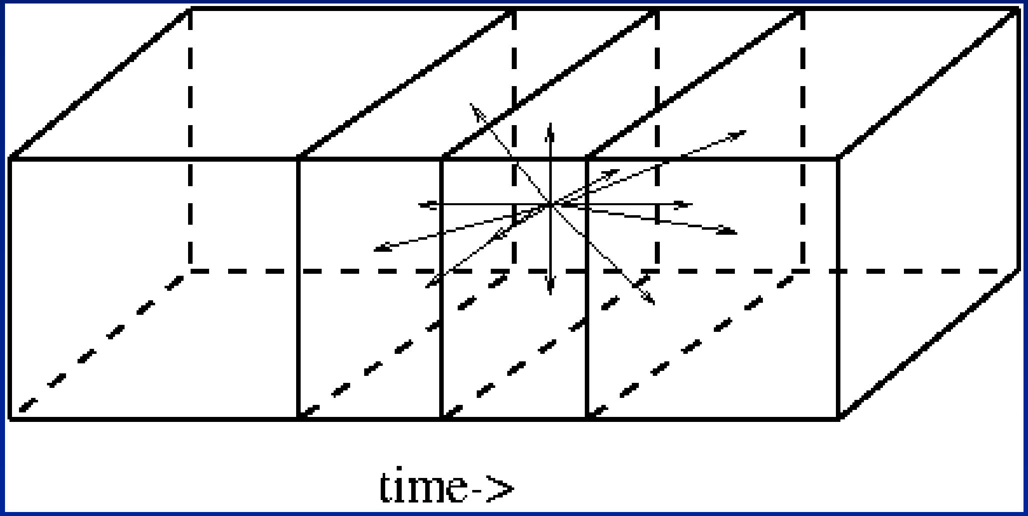
Multiple layers

- Multiple object motion

Motion decoupling



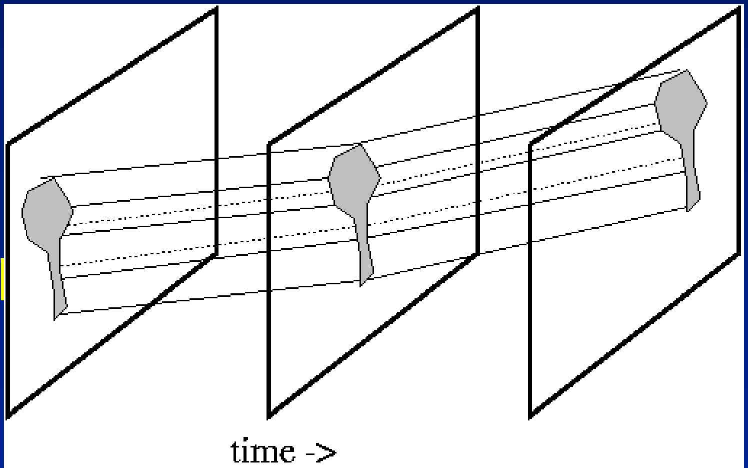
- Networks of spatial-temporal connections: Motion Segmentation with Normalized Cuts



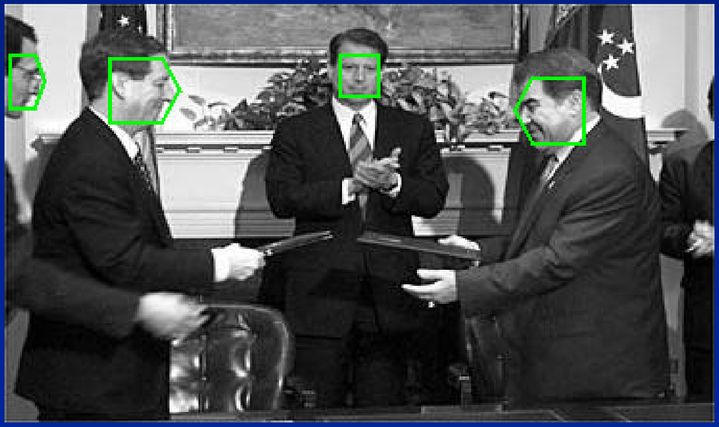
Motion Segmentation with Normalized Cuts

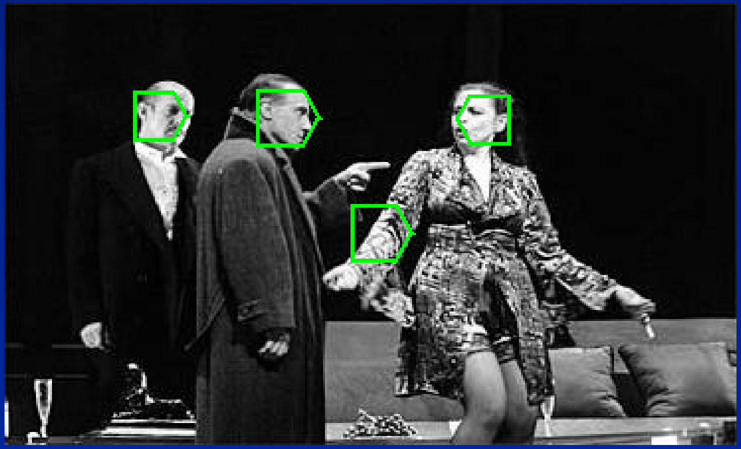
- Motion “proto-volume” in space-time

- Group co



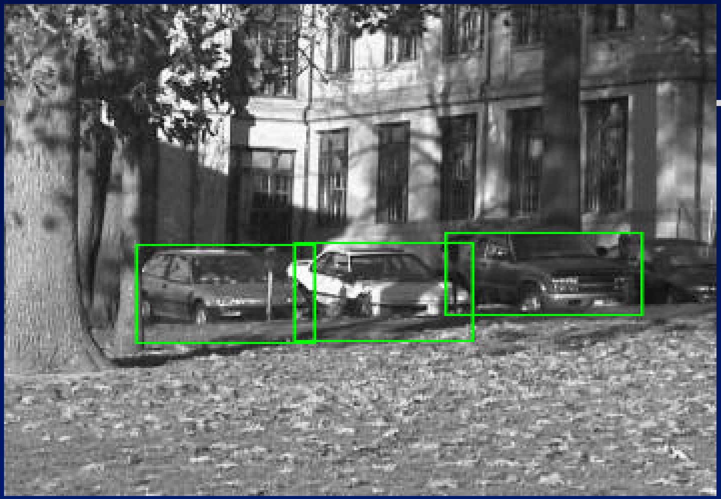
Rapid training of new objects in Video

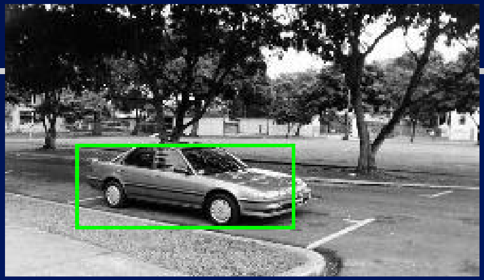


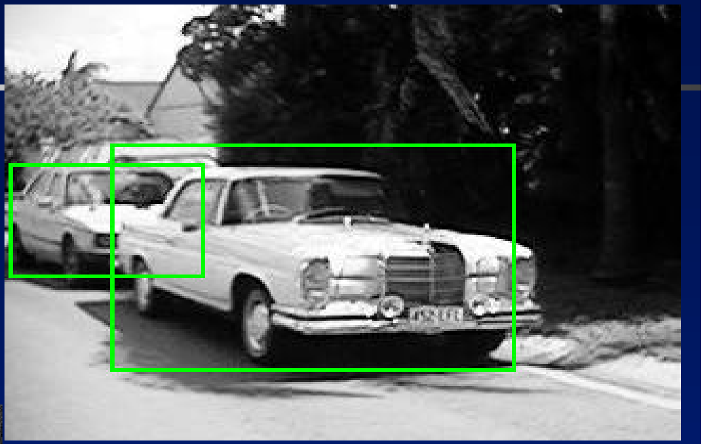


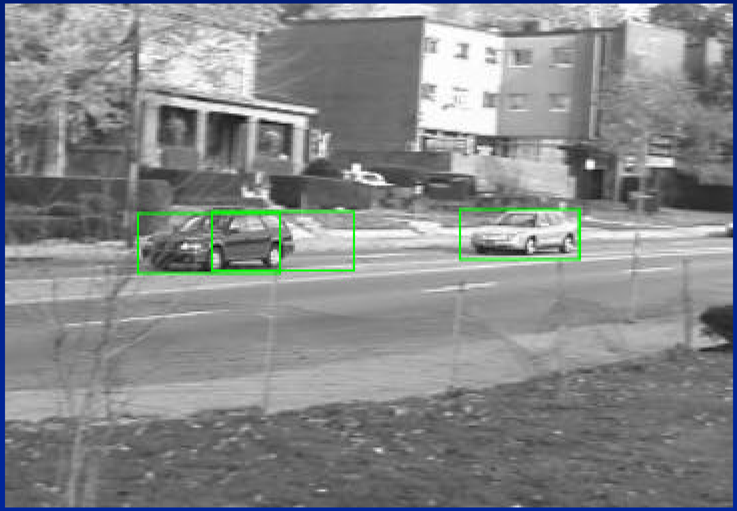
Multi-level object representation/training

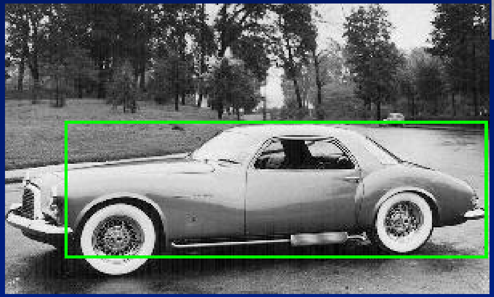
- Representation objects/scene at multiple level of abstraction
  - Low level motion, texture description
  - Mid level object segmentation
  - High level object type and instances

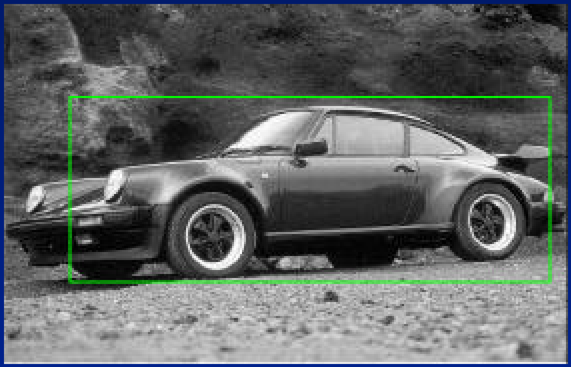


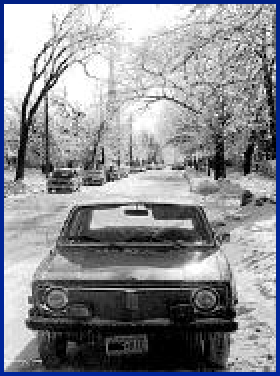


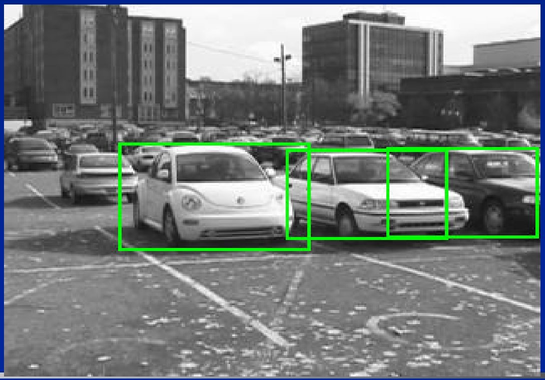


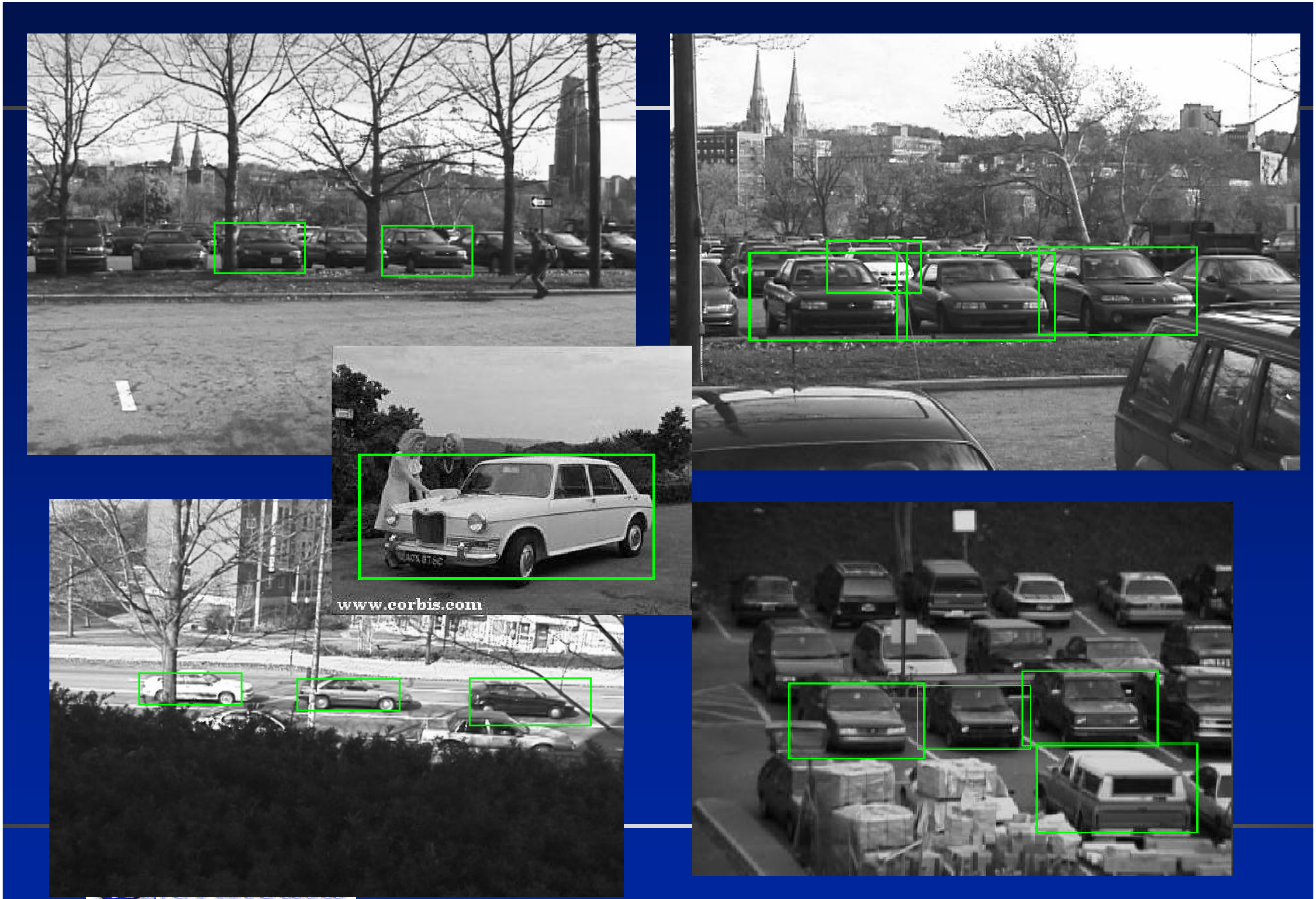








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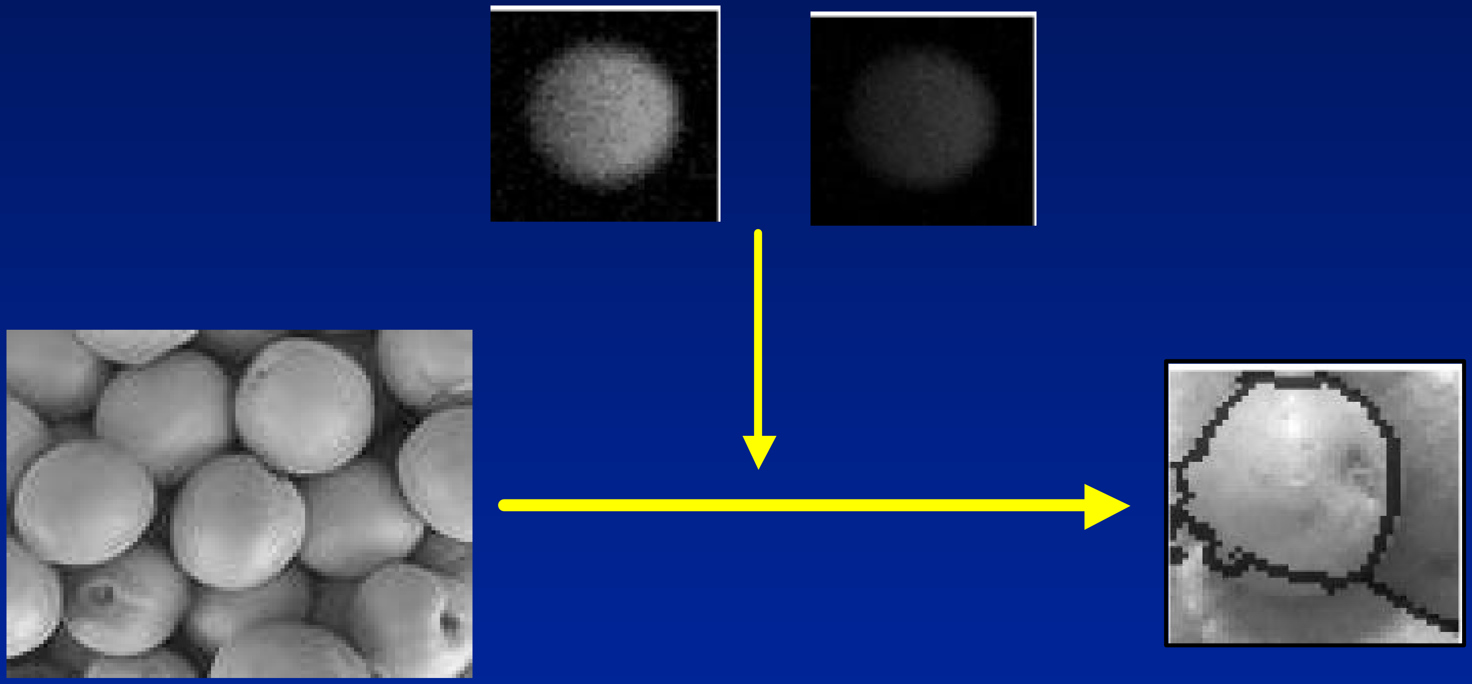
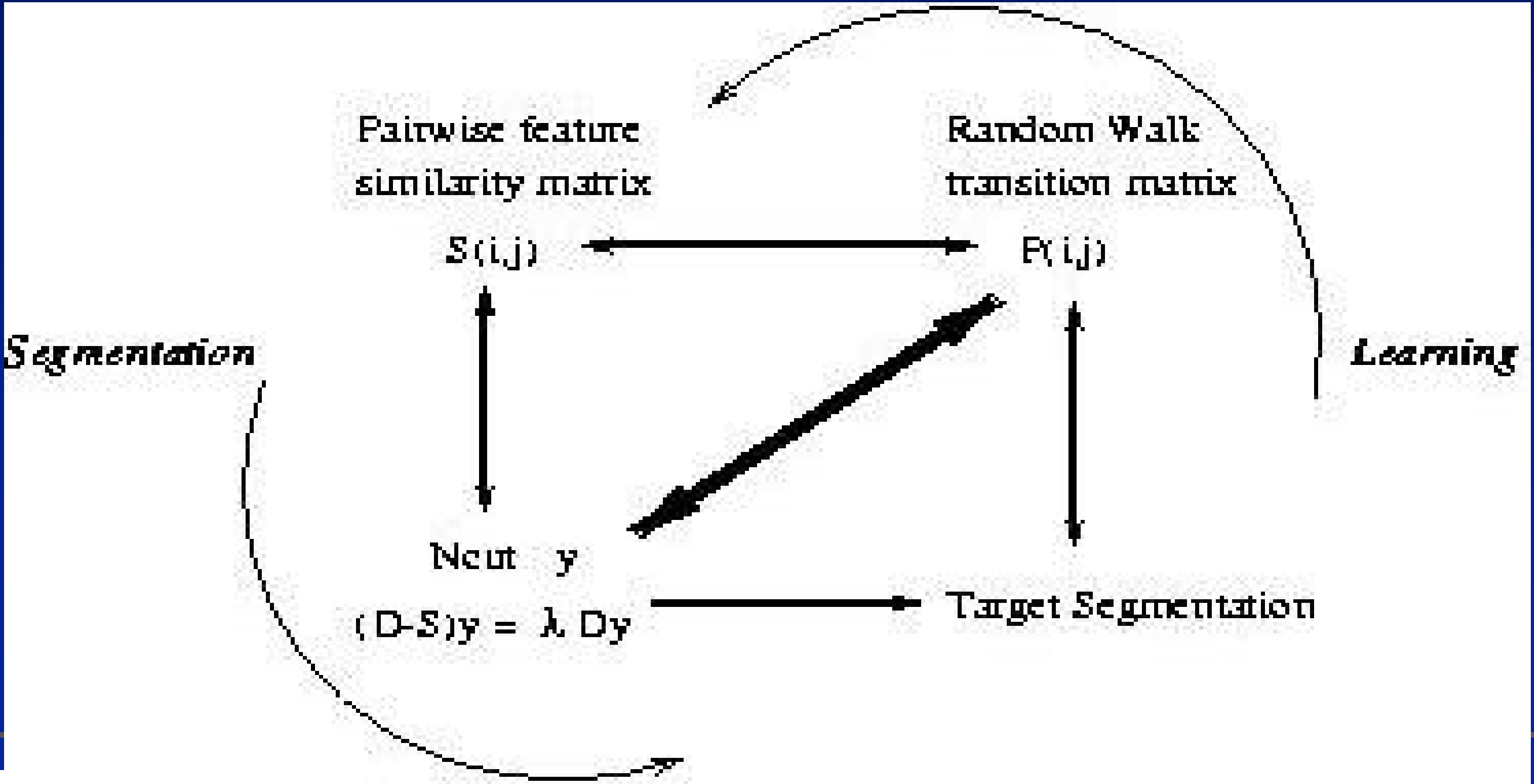
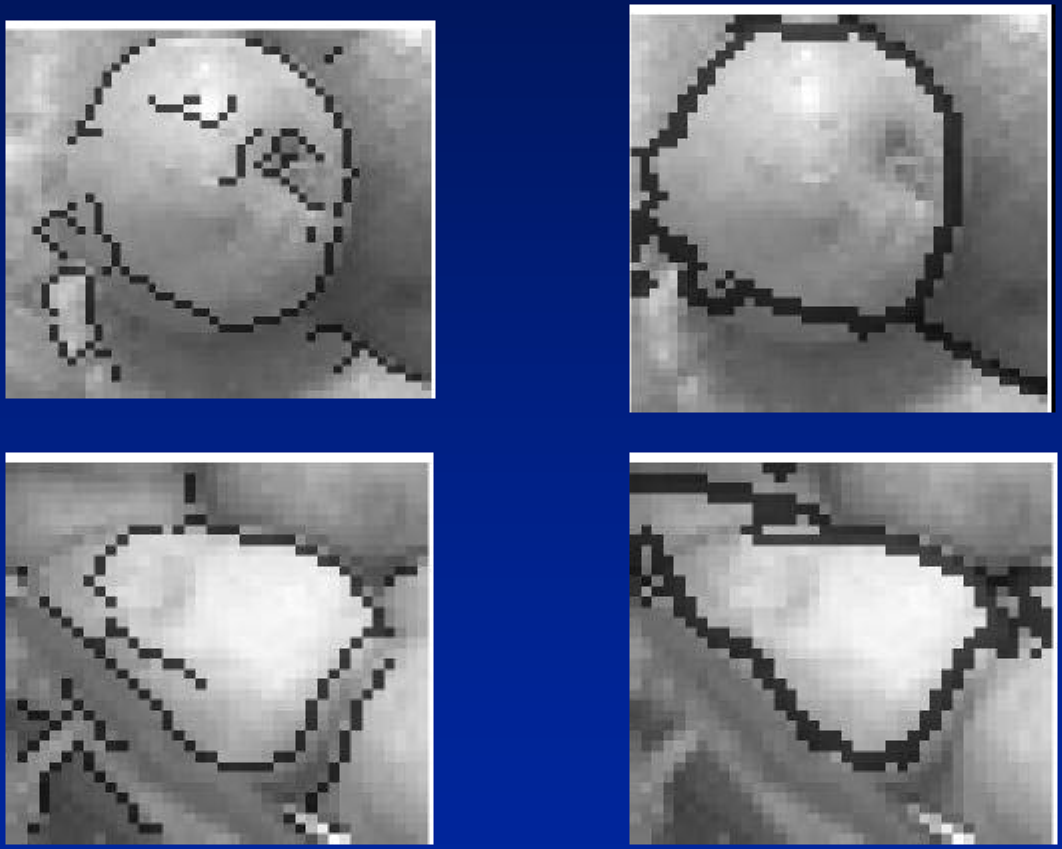
Learning Segmentation



Learning Seg. With Random Walk



Learning Convexity



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Learning Verbal image query

- Looking for cell phone images

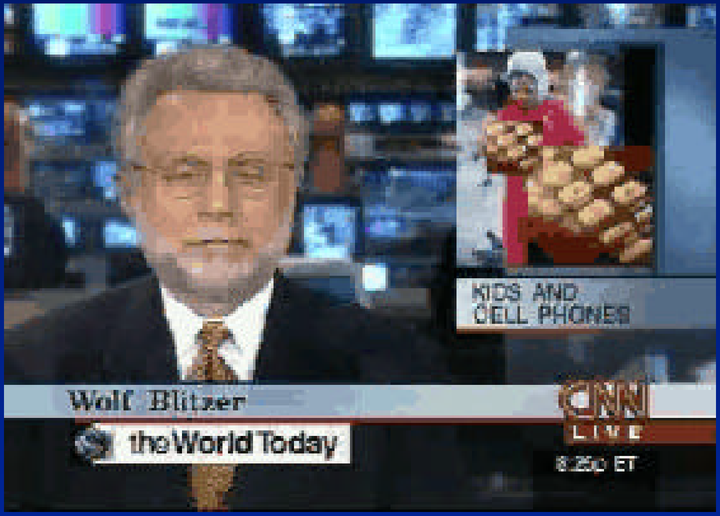

Image learning from text

- Keyword annotation is not sufficient
  - Too many objects
  - Disagreement of keywords

Conclusion

- Move towards more powerful image-query system in Video

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Data-mining from Co-relation
Between Video and Text